

CLEAN AIRITHMETIC

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Doing Sums to
Protect Your Lungs

WELCOME :D

When people are sick, they exhale infectious particles, even if they're asymptomatic. Respirators greatly lessen the spread of those particles, but they aren't perfect. Air purifiers are an excellent additional layer of safety!

This zine will show you...

- how to calculate how much air filtration you need for a given activity, and
- how much time it takes to clean the air in a given space,

so you can have more fun, more safely, with your pals!

DON'T I JUST NEED 6 ACH?

6 ACH (air changes per hour) was an oft-quoted target in the early 2020s. It was the recommendation for hospital isolation rooms as far back as 1970, and it isn't a bad target, but it fails to account for how many people are in a room and how heavily they're breathing.

So how much filtration do you actually need? Gentle reader... all will be made clear... I implore you to forge ahead...

HOW MUCH FILTRATION

Step 1: Find the activity/space on the ASHRAE table below that best matches your situation, and note its recommended CFM per person.

Step 2: Multiply the corresponding CFM per person by the maximum number of people at your activity.

Activity/Space	CFM/person
home or office	30
retail or classroom	40
lecture hall, auditorium, or residential common space	50
food and beverage facility or convention	60
health care patient room	70
gym	80

ASHRAE 241-2023 guidelines for Control of Infectious Aerosols

Definitions

- ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers
- CADR: clean air delivery rate.
- CFM: cubic feet per minute (ft^3/min). Often used as a unit of CADR.

Mechanical engineers use this guidance to figure out the minimum CADR needed to clean the air for a given kind of activity/space, and you can, too!

DO YOU NEED?

Example: You're setting up a class for a total of 20 attendees plus 5 instructors and assistants. What should the target CADR be, according to ASHRAE guidelines?

Step 1: Find the activity/space on the ASHRAE table that best matches your situation, and note its recommended CADR.

Activity/space: classroom

CFM/person: 40 CFM

Step 2: Multiply the corresponding CFM per person by the maximum number of people at your activity.

40 CFM/person x 25 people = 1000 CFM

Notes

Once you know how much CADR you need, get some air purifiers whose CADRs add up to your target. CADR is additive, so two 200 CFM air purifiers clean the same amount of air as one 400 CFM purifier; your clean air doesn't have to all come from one purifier!

In fact, more purifiers are better than fewer, even if the total CADR is the same! Spacing out a few purifiers reduces the maximum distance between a given infection source and a purifier, which reduces the likelihood of infectious spread.

HOW LONG UNTIL

Step 1: Calculate the volume of your space.

Make sure that your units are the same as those used in the CADR units of your air purifiers (e.g. if your purifier's in CFM, then use feet for this step).

If you know the square footage of your space, then you can multiply it by the ceiling height to get the volume. Otherwise, if your rooms are roughly box-shaped, use length x width x height to get the volume of each room, then sum those volumes to get your total volume.

Step 2: Add up the CADRs of all your air purifiers.

Remember, CADR is additive, so you can just add them up! This gives you your total CADR.

Step 3: Divide your space's volume by your total CADR.

This tells you the time it takes to get one air change, which is the industry term for when the same volume of air that's in your space has passed through your filter. Somewhat counterintuitively, that doesn't mean that your air is completely clean, which is why we still have one more step.

Step 4: Multiply the time for one air change by three.

In the time one air change takes, some air close to the purifier will have gone through multiple times, and some faraway air won't have gone through at all.

To compensate for this, we aim for multiple air changes. Three air changes get you to 95% clean air. (In general, n air changes will clean $1-(1/e^n)$ of your air.)

YOUR AIR IS CLEAN?

Example: You live in a 600 ft² apartment with 10' ceilings. Your two air purifiers put out, respectively, 330 and 170 CFM of clean air. A plumber comes over to fix your pipes; you wear a respirator while they're over, but they don't. After they leave, how long should you wait if you want to make sure the air is 95% clean before taking your respirator off?

Step 1: *Calculate the volume of your space.*

$$\begin{aligned}\text{total volume} \\ &= 600 \text{ ft}^2 \times 10 \text{ ft} \\ &= 6000 \text{ ft}^3\end{aligned}$$

Step 2: *Add up the CADRs of all your air purifiers.*

$$\begin{aligned}\text{total CADR} \\ &= 330 \text{ CFM} + 170 \text{ CFM} \\ &= 500 \text{ CFM}\end{aligned}$$

Step 3: *Divide your space's volume by your total CADR.*

$$\begin{aligned}\text{time for one air change} \\ &= 6000 \text{ ft}^3 \div 500 \text{ CFM} \\ &= 12 \text{ min}\end{aligned}$$

Step 4: *Multiply the time for one air change by three.*

$$\begin{aligned}\text{time to 95\% clean air} \\ &= 12 \text{ min} \times 3 \\ &= 36 \text{ min}\end{aligned}$$

ADDITIONAL RESOURCES

Unsure how much clean air your purifier puts out? Clean Air Stars has a Google spreadsheet of air purifiers that provides helpful information, including CADR, on hundreds of air purifiers (including a few CR boxes, which are called “DIY —” in this spreadsheet). You can find it by scanning this QR code or by going to filters.cleanairstars.com and following the “full dataset” link.



(We aren't affiliated with Clean Air Stars; we just think they're neat.)

This zine was made with love and by hand by members of COVID Action Montreal. You can find us on the World Wide Web at covidactionmtl.com.



Thanks for reading, and
stay safe out there <3